DUAL-FUNCTIONING MECHANISM FOR STARTUP DURING WINDING OF WEB MATERIAL AND FOR SPLICING DURING UNWINDING

BACKGROUND OF THE INVENTION

The invention relates to the winding of web materials about winding cores to form rolls of the materials, and the subsequent unwinding of the web materials from the rolls and splicing of a web tail end of a depleted roll to the web leading end of a new roll.

Web materials such as polymer film, paper, nonwoven or woven textile, metal foil, sheet metal, and others, are used in the manufacture of a variety of products. The web materials generally are provided in the form of large rolls formed by winding the web material about a winding core. To begin the winding process, a tail end of a web is attached to the winding core and the core is rotated about its axis to wind the web into a roll.

To manufacture products, the web material is unwound from the roll and subjected to converting operations, the particulars of which vary depending on the products being made. When the web from one roll is fully unwound, a splicing operation is performed wherein the leading end of the web from a new, full roll is attached to the tail end of the just-depleted roll, so that web material may be continuously supplied to the converting machinery.

Various approaches to the splicing of web material have been used, but the operation generally entails the use of some type of adhesive tape or substance for attaching the tail and leading ends of the webs together. If the adhesive were present on the tail end of a web prior to winding, the adhesive generally would have to face away from the core because that is the side of the web that will be brought into contact with the leading end of the new web to form the splice. Accordingly, the adhesive would stick to the subsequent turn of the web when the web is wound into a roll, which is clearly undesirable. Thus, some provision for preventing such sticking is necessary. U.S. Patent No. 5,855,714 to Bockh proposes to overcome this difficulty by providing a non-adherable region on the tail end of the web adjacent the adhesive. The non-adherable region is long enough to extend at least one full turn about the core so that the adhesive is

contacted by the non-adherable region and thereby is prevented from sticking. It may not be convenient or practical to form a non-adherable region on some types of web material, and in any event it would require a separate operation on the web prior to winding.

Additionally, mechanisms for splicing web materials generally have not aided or performed any function associated with the winding of the web into a roll.

BRIEF SUMMARY OF THE INVENTION

The present invention addresses the above needs and achieves other advantages, by providing a dual-functioning mechanism that aids in splicing of webs and that can also aid in the startup of the winding process. The mechanism in certain embodiments of the invention generally comprises two components that initially are attached to each other at the startup of winding, but that detach from each other at completion of unwinding so as to expose a previously unexposed adhesive region that can attach to the leading end of another web to accomplish a splice. The mechanism is connected between the tail end of a web and a winding core so as to affix the web to the core prior to winding the web into a roll about the core. The attachment of the web to the core provided by the mechanism is sufficiently strong to withstand the tension exerted on the web at the start of winding without the two components of the mechanism detaching from each other. At completion of unwinding, however, the tension exerted on the web tending to pull the two components apart serves to separate the components and thereby expose an adhesive region on the component that remains attached to the tail end of the web.

The mechanism generally comprises a core component for attachment to the core and a web component for attachment to the web. In some embodiments of the invention, the core component has a core-attaching portion structured and arranged to attach to the core and a free end portion joined to the core-attaching portion, the free end portion extending out from the core when the core-attaching portion is attached to the core. The web component has a tail portion structured and arranged to attach to a tail end of a web and a leading portion joined to the tail portion, the leading portion extending out from the tail end of the web when the tail portion is attached to the tail end. The leading portion has adhesive disposed thereon and is adhered to the core component with sufficient

adhesive bonding strength to remain attached when winding tension is exerted between the core and the tail end of the web during startup of winding of the web onto the core to form a roll. However, the adhesive bonding strength is low enough to allow the leading portion of the web component to detach from the core component at completion of unwinding of the roll such that the adhesive on the leading portion extending from the tail end of the web is exposed for attachment to a leading end of another web being unwound from a new roll to splice the webs together.

The adhesive on the leading portion of the web component in one embodiment is substantially completely covered by the free end portion of the core component when the two components are joined together at startup of winding of the web. In this manner, the adhesive on the leading portion is prevented from sticking to a subsequent turn of the web during winding.

The web component conveniently can comprise a splicing tape. A portion of the length of the tape is affixed to the tail end of the web, and the remaining portion of the length extends beyond the tail end for attachment to the core component.

The core component can have various configurations and constructions. In one embodiment of the invention, the core component comprises a substrate (e.g., paper, plastic film, cloth, etc.) that includes a release material disposed on one side of the substrate over a portion of the substrate length. The remainder of the substrate length (or at least a part thereof) is attached to the core prior to winding of a web about the core. An adhesive can be applied to the core for the attachment of the substrate, or adhesive can be disposed on the substrate, or adhesive can be disposed on both the core and the substrate.

In accordance with another embodiment of the invention, the core component comprises a substrate having an upper surface and a lower surface, with a release material covering the upper surface. A portion of the length of the substrate is folded over such that part of the substrate comprises two layers and the rest comprises a single layer. The part having two layers forms the free end portion for attachment to the web component, and has the release material disposed on both of its opposite surfaces by virtue of the

folded-over portion. The part having one layer forms the core-attaching portion that is attached to the core prior to winding. Advantageously, the folded-over portion of the substrate is free to unfold upon completion of unwinding when the tail end of the web is pulled away from the core. As the folded-over portion of the substrate is unfolded, it moves into a more-advantageous orientation relative to the web component attached to it for peeling the web component off the substrate.

The core-attaching portion of the core component can have a double-sided adhesive tape, or a layer of adhesive, disposed on its lower surface for attaching the core component to the core. The core-facing side of the adhesive tape, or the adhesive layer, can have a release liner attached to it to prevent sticking of the core component to various objects until it is desired to attach the core component to the core. The release liner can be peeled off to expose the adhesive tape or adhesive layer just prior to attaching the core component to the core.

Similarly, prior to attaching the web component to the tail end of the web, the portion of the web component that is not attached to the core component can have a release liner attached to the adhesive surface. The release liner can be peeled off to expose the adhesive surface just prior to attaching the web component to the web.

In another embodiment of the invention, the web component comprises a splicing tape having a tail portion attached to the tail end of the web and a leading portion that extends out from the tail end. The leading portion is folded beneath the tail portion so that the adhesive on the leading portion faces away from the tail portion. The leading portion is adhered to the release surface of the core component. The core component can comprise a substrate having one portion attached to the core and a free end portion that extends out from the core. Alternatively, the core component can comprise a layer of release material disposed on the core. Upon unwinding, the folded splicing tape unfolds and detaches from the core component, thereby exposing the adhesive on the leading portion of the splicing tape for splicing the tail end of the web to a leading end of another web.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. 1 depicts a cross-sectional view of a startup and slicing mechanism in accordance with a first embodiment of the invention;

FIG. 2 is a perspective view of an unwinding roll of web material wherein the tail end of the web is attached to the core by the mechanism of FIG. 1;

FIG. 3A is a cross-sectional view through the web and mechanism along line 3-3 in FIG. 2, at a moment in time when the tail end of the web just begins to be advanced away from the core of the unwinding roll;

FIG. 3B is a view similar to FIG. 3A, at a later moment in time when the web component of the startup and splicing mechanism attached to the tail end of the web begins to separate from the core component of the mechanism attached to the core;

FIG. 3C shows the tail end of the web at a moment in time subsequent to that of FIG. 3B, after the web component has completely separated from the core component so as to expose the adhesive on the leading portion of the web component;

FIG. 3D depicts the tail end of the web being spliced to a leading end of a new roll of web material by adhering the leading end of the web to the exposed adhesive on the web component;

FIG. 4 illustrates a startup and splicing mechanism in accordance with a second embodiment of the invention;

FIG. 5 shows a startup and splicing mechanism in accordance with a third embodiment of the invention;

FIG. 6 depicts a startup and splicing mechanism in accordance with a fourth embodiment of the invention;

FIG. 7 shows a startup and splicing mechanism in accordance with a fifth embodiment of the invention, attaching a tail end of a web to a core;

FIG. 8A illustrates a startup and splicing mechanism in accordance with a sixth embodiment of the invention, attaching a tail end of a web to a core, at a moment in time when the tail end of the web just begins to be advanced away from the core of the unwinding roll; and

FIG. 8B is a view similar to FIG. 8A, at a later moment in time when the web component of the startup and splicing mechanism has completely detached from the core so as to expose the adhesive on the leading portion of the web component.

DETAILED DESCRIPTION OF THE INVENTION

The present inventions now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, these inventions may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

A dual-functioning mechanism for startup and splicing of a web, in accordance with a first embodiment of the invention, is depicted in FIG. 1 and broadly designated by reference numeral **20**. The mechanism **20** comprises a web component **30** for attachment to a tail end of a web and a core component **40** for attachment to a winding core. The web component comprises a splicing tape **32** formed by a backing **34** of suitable sheet material (e.g., paper, plastic film, cloth, etc.) and a layer of adhesive **36** covering one side of the backing. A release liner **38**, which can comprise, for example, a silicone-coated paper or the like, covers the adhesive **36** on one lengthwise portion of the splicing tape and is adhered to the adhesive in releasable fashion. The remaining length of the splicing tape is adhered by the adhesive **36** to a portion of the core component **40**. The adhesive **36** preferably comprises a pressure-sensitive adhesive (PSA), i.e., a material that adheres to a wide variety of materials upon application of pressure.

The core component **40** comprises a substrate **42** of suitable sheet material (e.g., paper, plastic film, cloth, etc.). A layer of adhesive **44** is disposed on one side of one lengthwise portion of the substrate. A release liner **46**, which can comprise, for example, a silicone-coated paper or the like, covers the adhesive **44** and is adhered to the adhesive in releasable fashion. An end region **48** of the substrate, which is preferably free of adhesive, is folded beneath an adjoining region **50** of the substrate, which also is preferably free of adhesive. The folded end region **48** is adhered to the portion of the splicing tape **32** that is not covered by the release liner **38**.

The surface of the folded end region **48** that is adhered to the splicing tape **32** preferably is such that it will readily peel off the splicing tape when the splicing tape is pulled away from the folded end region **48** in a direction out of the plane of the end region. To this end, the end region **48** can have a suitable release material (e.g., silicone, not shown) disposed thereon; alternatively, the material of the substrate **42** itself may be such that the splicing tape will readily peel off the end region. However, the adhesive bond between the splicing tape and the end region **48** preferably is sufficiently strong to resist detachment of the splicing tape when the splicing tape is pulled away from the end region in a direction lying in the plane of the end region, i.e., in a direction tending to place the adhesive interface in shear as opposed to peeling it apart.

As shown in FIG. 2, the mechanism **20** is used to attach a tail end **52** of a web ***W*** to the cylindrical outer surface of a winding core ***C*** to assist in startup of winding of the web about the core to form a roll ***R***. The mechanism also facilitates splicing the tail end to a leading end of another web during unwinding of the roll, as explained below in connection with FIG. 3D. The mechanism **20** is shown as having a width, i.e., a dimension along the longitudinal direction of the winding core, that is substantially equal to the length of the core. However, the width of the mechanism could be less than the core length, or a plurality of separate mechanisms could be spaced apart along the length of the core.

More particularly, the mechanism **20** is prepared for use by first peeling off the release liner **46** from the adhesive **44** on the substrate **42** of the core component **40**. The

portion of the substrate **42** having the thus-exposed adhesive **44**, which is referred to herein as the core-attaching portion, is affixed to the outer surface of the core ***C*** via the adhesive **44**. The remaining portion of the substrate **42** remains unaffixed to the core and is referred to herein as the free end portion, and comprises the folded end region **48** and the adjoining overlying portion **50**. The folded end region **48** thus lies between the outer surface of the core and the overlying portion **50** of the substrate. The free end portion of the substrate is affixed to the portion of the splicing tape **32** that is not covered by the release liner **38**, which is referred to herein as the leading portion of the splicing tape.

Next, the release liner **38** is peeled off the splicing tape **32** to expose the adhesive **36** on the remaining portion of the splicing tape, which is referred to herein as the tail portion of the splicing tape. The tail portion of the splicing tape is then adhered to the tail end **52** of the web ***W*** via the thus-exposed adhesive **36**. The web is now ready to begin winding about the core.

By virtue of the construction and arrangement of the mechanism **20**, it will be recognized that as the core is rotated to begin winding the web about the core, the tension force between the core and the tail end tends to place the adhesive bond between the web component **30** and the core component **40** in shear rather than peeling it apart, and the web component remains attached to the core component. The core component **40** resists unfolding because the folded end region **48** is trapped between the core and the overlying portion **50**. Thus, the mechanism **20** is sufficiently strong to remain intact under the levels of tension exerted during the startup of the winding process.

However, at the completion of unwinding of the roll during a converting operation or the like, the web component **30** readily detaches from the core component **40** such that the web component remains attached to the tail end of the web and provides an exposed adhesive surface for splicing the tail end to another web, as further explained below with reference to FIGS. 3A through 3D.

FIG. 3A shows an unwinding roll at the completion of the unwinding operation, at the moment in time when the tail end **52** of the web just begins to be advanced away from the winding core and the free end portion of the substrate **42** of the core component

begins to be pulled away from the outer surface of the core. At this point, the folded end region **48** is no longer prevented from unfolding by pressure exerted by the overlying portion **50**.

FIG. 3B shows a later instant in time as the tail end **52** continues to be advanced away from the core and the core continues to rotate. The substrate **42** of the core component begins to unfold as a result of the force exerted on the folded end region **48** by the splicing tape **32**. Consequently, the end region **48** and splicing tape **32** are placed in relative orientations favoring peeling apart of the splicing tape and end region.

FIG. 3C shows a still later instant in time when the splicing tape **32** has completely detached from the substrate of the core component (which remains attached to the core, not shown). The splicing tape thus has a leading portion that extends away from the tail end **52** of the web and presents the adhesive **36** on the surface of the splicing tape facing away from the core.

As depicted in FIG. 3D, the splicing tape **32** is used to splice the tail end **52** of the web to a leading end **54** of a new roll ***R'*** of web material. Various devices and processes can be used for accomplishing the splice, FIG. 3D merely showing in a highly schematic fashion that in general the leading end **54** and the splicing tape **32** are placed in overlying relation and pressure is exerted to press them together so that the leading end adheres to the splicing tape. The mechanism **20** is suitable for automated splicing operations performed while the webs are moving, often referred to as "flying" splices.

FIG. 4 shows a second embodiment of a dual-functioning mechanism **20'** in accordance with the invention. The mechanism **20'** is generally similar to the mechanism **20** described above, having a web component **30'** as previously described and a core component **40'** that differs somewhat from that of the first embodiment. In particular, the core component does not include adhesive on the substrate **42'**; instead, an adhesive **44'** is applied to the outer surface of the core just prior to affixing the core component to the core. Additionally, the substrate **42'** has a coating of release material **43'** (e.g., silicone or the like) on its upper surface. Thus, the release material is disposed on the core-facing side of the folded end region that is adhered to the splicing tape of the web component

30', and facilitates detachment of the splicing tape from the core component. The mechanism **20'** functions in essentially the same way as the previously described mechanism.

FIG. 5 depicts a third embodiment of a mechanism **20''** in accordance with the invention. The mechanism **20''** is generally similar to the mechanism **20** of FIG. 1. The web component **30''** is identical to the web component **30** of the first embodiment. The core component **40''** is similar to the previously described core component **40**, except that a double-sided adhesive tape **56** is attached to the substrate **42''** for providing the adhesive surface by which the substrate is affixed to a winding core. One side of the double-sided tape **56** is affixed to the substrate. The opposite side of the tape has a release liner **46''** releasably adhered thereto; the liner is removed just prior to affixing the core component to a core. The substrate **42''** includes a coating of release material **43''** as in the embodiment of FIG. 4. The mechanism **20''** functions in essentially the same manner as described in connection with FIG. 1.

A fourth embodiment of a mechanism **120** in accordance with the invention is shown in FIG. 6. The mechanism includes a web component **130** releasably attached to a core component **140**. The web component **130** comprises a splicing tape **132** having a backing **134** of suitable material (e.g., paper, plastic film, cloth, etc.) and a layer of adhesive **136** covering one side of the backing. Whereas in the first embodiment of FIG. 1 the core component is folded while the web component is flat, in the present embodiment the web component is folded while the core component is flat. Thus, the splicing tape **132** has a portion **132a** that is folded beneath the rest of the tape; the portion **132a** is referred to herein as the leading portion because it is the part of the tape that will extend out from the tail end of a web for splicing, as further explained below. The rest of the tape that overlies the folded or leading portion **132a** is referred to herein as the tail portion because it is the part of the tape that is adhered to the tail end of the web. The adhesive **136** on the leading portion **132a** faces away from the overlying tail portion, and is releasably adhered to a portion of the core component **140**. A release liner **138** covers the adhesive **136** on the tail portion of the splicing tape, and is removed just prior to attaching the tail portion to the tail end of a web.

The core component **140** includes a substrate **142** of suitable material (e.g., paper, plastic film, cloth, etc.). One side of a first lengthwise portion of the substrate (referred to herein as the free end portion) is releasably adhered to the folded leading portion **132a** of the splicing tape. On the opposite side of a second lengthwise portion of the substrate (referred to herein as the core-attaching portion) is a layer of adhesive **144**; a release liner **146** covers the adhesive **144** and is removed just prior to affixing the core-attaching portion of the substrate **142** to a winding core. The free end portion of the substrate **142**, to which the splicing tape **132** is adhered, remains unaffixed to the core. Before startup of winding of a web about the core, the release liner **136** is removed from the splicing tape and the tape is attached to the tail end of the web. The winding core is rotated to begin winding the web about the core.

During unwinding of the web from the roll, when the tail end of the web begins to be advanced away from the winding core, the splicing tape **132** peels off the substrate **142** and unfolds in the process. Once the splicing tape completely detaches from the substrate of the core component, the splicing tape assumes the configuration as shown in FIG. 3C and is positioned for splicing the tail end of the web to a leading end of another web as illustrated in FIG. 3D.

A fifth embodiment of a mechanism **220** in accordance with the invention is shown in FIG. 7. The mechanism **220** includes a web component **230** comprising a splicing tape **232** and a core component **240** comprising a substrate **242** having adhesive **244** on a core-attaching portion of the substrate. Both the splicing tape and the substrate are flat (i.e., not folded). A leading portion of the splicing tape **232** is releasably adhered to a free end portion of the substrate **242**, and a tail portion of the splicing tape is adhered to the tail end **52** of a web. The mechanism thereby attaches the tail end to the core to assist in startup of winding of the web about the core to form a roll. At completion of unwinding of the roll, as the tail end of the web pulls the splicing tape **232** away from the core, the adhesive interface between the splicing tape and the core component **240** is initially placed in shear; the resulting shear stress may be sufficient to break the adhesive bond and detach the splicing tape from the core component. Alternatively, as the core continues to rotate, the core component will begin to fold back on itself, placing the core

component and splicing tape in a more-advantageous relative orientation to peel the core component off the splicing tape. Once the splicing tape completely detaches form the core component, the splicing tape assumes the configuration as shown in FIG. 3C and is positioned for splicing the tail end of the web to a leading end of another web as illustrated in FIG. 3D.

FIGS. 8A and 8B depict a mechanism **320** in accordance with a sixth embodiment of the invention. The mechanism **320** includes a web component **330** comprising a folded splicing tape **332** substantially as described in connection with FIG. 6. The core component **340** comprises a layer of release material **343** disposed on the cylindrical outer surface of the winding core. The leading folded portion of the splicing tape **332** is releasably adhered to the release material **343** on the core and the tail portion of the splicing tape is adhered to the tail end **52** of a web so as to attach the tail end to the core and thereby assist in startup of winding of the web about the core. At completion of unwinding, as the tail end of the web is advanced away from the core, the splicing tape **332** is pulled away from the core and unfolds and peels off from the release material **343** of the core component. Once the splicing tape completely detaches form the core component **340**, the splicing tape assumes the configuration as shown in FIG. 8B and is positioned for splicing the tail end of the web to a leading end **54** of another web. while the release material **343** is shown as covering the entire outer surface of the core, alternatively the release material could be isolated to that portion of the outer surface to which the splicing tape is to be adhered.

The mechanism **320** includes a splice-detection element **333** incorporated into the splicing tape **332**. As shown, the splice-detection element **333** is disposed on the surface of the splicing tape **332** opposite the surface that attaches to the web, and is located on the tail portion of the splicing tape; alternatively, the splice-detection element could be located on the other surface of the tape, or could be embedded or impregnated in the thickness of the tape, and/or could be located on the leading portion of the tape. The splice-detection element is detectable by a suitable sensor so that the location of the splice between webs can be automatically sensed. This is useful during a converting operation, for example, because products made from the portion of the web material

containing the splice must be discarded; the ability to automatically detect the splice can enable automatic discarding of such defective products. The splice-detection element can be detected in various ways, including but not limited to optical detection or metal detection (e.g., induction imbalance, pulse induction, or beat frequency oscillation). Thus, the splice-detection element may have an optically detectable property (e.g., opacity, color, reflectivity, etc.). Alternatively, the splice-detection element may incorporate metal (e.g., metal foil, iron shavings, etc.).

Any of the other embodiments shown in FIGS. 1 through 7 may also include a splice-detection element, if desired.

While a release material is shown in the embodiments of FIGS. 4, 5, and 8A, the release material may be omitted if the surface to which the splicing tape is adhered is such that the splicing tape will readily and cleanly detach from the surface. Conversely, the embodiments of FIGS. 1-3, 6, and 7, although not specifically shown as including a release material, can include a release material if desired.

Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.